Pika ENERGY™

Pika T701 Turbine Operation Manual

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Operation Manual

Revision 1.3

Turbine Serial #_____

Introduction

Congratulations on your purchase of the T701 wind turbine! This manual will help the user operate the Pika Energy T701 turbine most effectively. Pika Energy recommends storing this manual in a sealed waterproof container located near the inverter for ready access.

Symbols used in this document

Throughout the manual, the following symbols highlight important information:

	**WARNING:** Actions or situations that could permanently damage or destroy the T701 turbine or other system components
	**NOTE:** Helpful tips and points of interest

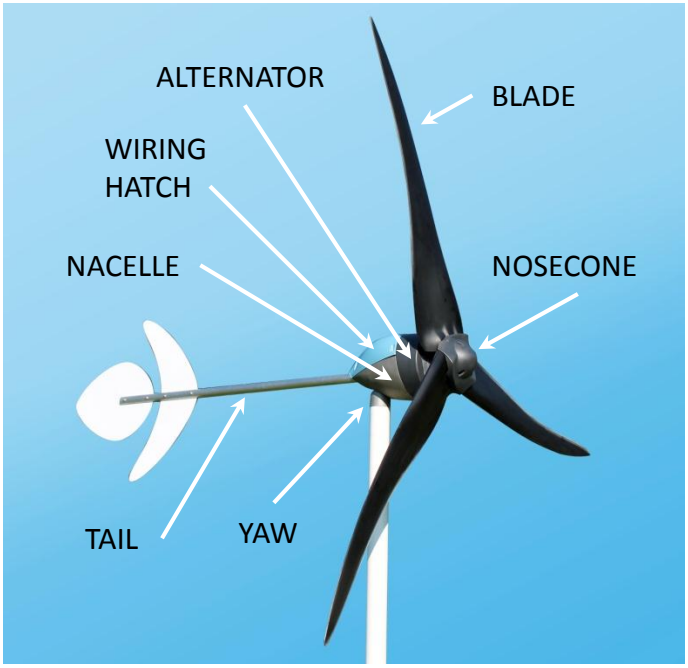
Revision Table

Revision	Date	Changes
1.1	2013-11-10	Draft
1.3	2014-01-30	Remove slow-fast

Contents

1 Turbine overview

The T701 turbine is a horizontal-axis, three-blade, passive-yaw upwind turbine with a rotor diameter of 3.0 meters and a peak output of approximately 1.8kW. The turbine features high-performance molded blades and a quiet, efficient permanent-magnet alternator. Rotor speed is maintained within a safe operating range by the alternator through active load control. An exclusive patent-pending mechanical overspeed brake can operate entirely independent of the primary load control to ensure that the turbine can never overspeed, even in the case of component failure. The basic elements of the T701 wind turbine are illustrated in [FIGURE].



1.1 Turbine Components

Blades

The T701 turbine's blades capture wind energy and convert it into mechanical energy. Your turbine features tough, high-performance aerodynamic blades made of glass-reinforced thermoplastic.

Alternator

The alternator converts mechanical energy to electrical energy. Your turbine features a custom-engineered quiet, powerful generator, and uses powerful rare-earth magnets for high efficiency. The alternator also controls the speed of the rotor to limit power in high winds.

Nacelle

The nacelle is the backbone of the turbine, connecting the blades, mainshaft, alternator, bearings, and tail. The T701 nacelle features a strong, aerodynamic casting made from recycled aluminum.

Safety Brake

The T701 turbine features an exclusive, fast-acting safety brake that stops the rotor in case of an overspeed (runaway) condition. See the TROUBLESHOOTING section for more information on operation of the safety brake.

Tail

The tail assembly of the T701 turbine operates like a wind vane, to ensure that the turbine always points upwind.

Yaw

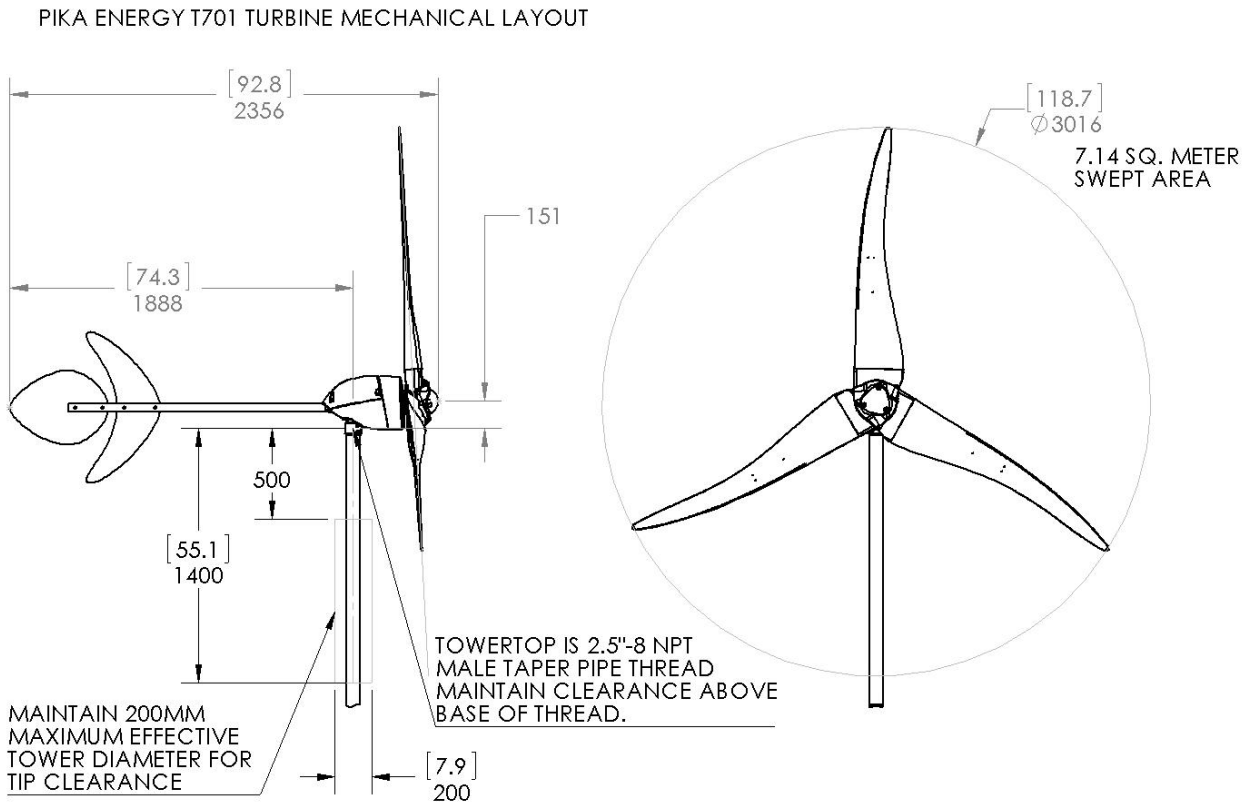
The yaw assembly connects the turbine securely to the top of the tower, and contains ball bearings that allow the turbine to rotate smoothly to face the wind.

1.2 Turbine Specifications

The T701 turbine produces a regulated DC current output, and is designed exclusively for connection to a REbus DC microgrid. REbus is an advanced DC microgrid platform developed by Pika Energy for small-scale wind, solar, and hybrid systems. ***Read and understand the accompanying REbus Microgrid Introduction and Design Guide for more information on setting up a REbus microgrid.***

Parameter	**Value**
Turbine Type	3-blade HAWT, upwind free yaw
Rotor diameter	3.016 m
Swept area	7.01 m^2
Blade type	Optimum twist-taper injection-molded glass-reinforced polypropylene resin
Speed control	Digitally-controlled alternator torque
Redundant control	One-shot centripetal overspeed brake
Towertop mass	45 kg
Rated power (approx.)	1800W @ 11 m/s
Monthly output (approx.)	230 kWh at 5 m/s avg. (Rayleigh)
Cut-in windspeed	3.3 m/s
Survival windspeed	60 m/s
Turbine electrical output	REbus™ DC microgrid: regulated +/-190VDC
Electrical parameters	**Nominal (Maximum)**
REbus Power	1800 W (2400 W)
REbus voltage	380 V (420 V)
REbus current	4.7 A (6.7 A)

1.3 Turbine Mechanical Diagram



2 Turbine System Design and Installation

To give good performance, the T701 turbine must be installed as part of a well-thought-out system, designed in accordance with industry best practices. Pika's warranty agreement requires that the turbine be installed by a qualified, trained small wind turbine installer. Refer to the installation manual for specific instruction on system design and installation.

2.1 Applications

Base system : T701 Wind Turbine + X3001 REbus Inverter

The T701 turbine is connected to the building wiring and the AC grid through a REbus™ inverter, such as Pika Energy's X3001. This converts the turbine's REbus DC output to standard 60 Hz AC current for use in your home's appliances. If extra energy is available, the inverter automatically backfeeds the power into the grid. Unlike other inverters, Pika's X3001 REbus inverter provides the ultimate in system design flexibility, enabling multiple turbines or a combination of wind and solar to feed directly into the inverter. More information is available in the inverter manual and **REbus Microgrid Design and Installation Manual**.

PV Hybrid : T701 Wind Turbine + S2001 PV Link + X3001 REbus Inverter

Pika Energy offers a PV hybrid option with unmatched performance and flexibility. Up to 8 standard PV modules can be connected to the X3001 inverter in parallel with the T701 turbine through Pika's S2001

"PV Link" maximum powerpoint tracking converter. Contact Pika Energy for more information about this exciting option for boosting the performance of the T701 turbine system with solar.

Off-grid installations

The T701 Wind Turbine can be used in off-grid applications when combined with a REbus charge controller. Contact Pika to learn more about charge controller options that are currently available.

Other system designs

The REbus microgrid is designed to be a very flexible infrastructure that allows many configurations including multiple wind turbines on the same inverter. See the REbus Microgrid manual for more details.

2.2 Siting and Towers

The most important factor in the performance of any wind turbine is the quality of the wind resource experienced by the turbine. One of the most common causes of poor performance is installation on a tower that is too short. **For acceptable performance the tower must be *at least* 10 meters taller than the mature height of trees and other surrounding obstacles within a 100m radius. This is a minimum requirement,** and more height exposure is better. Remember that trees grow rapidly in height, and are likely to significantly decrease the wind exposure of nearby turbines over a few years. If in doubt, choose a taller tower.

2.3 Installing the T701 turbine

The T701 turbine has been designed to be fast and simple to install. However, it is important to carefully follow the instructions in the T701 Installation and Service Manual, as well as the installation manuals for the other system components.

3 Turbine System Operation

3.1 How to Use the Front Panel Display

Most T701 Wind Turbine installations will include a REbus system component with a user interface for assessing the state of the wind turbine controller. This section describes interfacing with the turbine from the front panel display of the X3001 REbus Inverter. Please consult the X3001 User Manual for instructions on using this interface.

3.2 Turbine Startup

Quickstart Summary (assuming turbine installation is complete and tested):

- ***Turn on AC power to the X3001 inverter***
- ***Enable the inverter from the front panel display***

In order to start up, the turbine must be properly installed, and connected to an active REbus™ microgrid. If power is disconnected to the inverter, the inverter is disabled, or a fault is detected in the REbus microgrid, the turbine will not come up to speed.

Turn on AC power to the inverter by switching on the circuit breaker (and AC disconnect, if present). When AC power is restored to the X3001 inverter, it resumes its previous state of operation from before the power interruption. The inverter is programmed at the factory to power up in the 'disabled' state when first energized.

Enable the inverter from the front panel display by selecting the X3001 inverter device in the device menu, then selecting 'enable' and confirming the selection. The inverter will perform a series of internal and external checks, then activate the REbus microgrid by raising the voltage to above 300V, activating the T701 turbine's internal controller.

When the T701 turbine's internal controller becomes active, it resumes its previous state of operation from before the power interruption. The turbine is programmed at the factory to power up in the 'disabled' state when first energized.

Enable the T701 turbine from the inverter front panel display by selecting the T701 turbine device in the device menu, then selecting 'enable' and confirming the selection.

3.3 Normal Operation

Light Winds

In winds below 3m/s, the wind does not provide enough torque to spin the blades. The wind turbine page on the inverter front panel display will report 'LOW WIND'. Light winds do not contain much energy. Every doubling of windspeed results in an 8X increase in energy, so in most sites the turbine will capture the majority of its energy output in winds above 6.5 m/s (15 mph).

Moderate Winds

The T701 wind turbine will start in windspeeds of 3-4 m/s (7-9 mph), and will produce a small amount of power in winds as light as 2.5m/s (6 mph). The wind turbine page on the inverter front panel display will report 'Making Power'.

In most installations, the power produced by the T701 is fed directly into the home's central distribution panel, and is used directly by the electrical loads of the home, decreasing the current draw from the utility. If the power output of the turbine exceeds the total demand of the home, excess power flows back into the utility grid, 'turning the meter backwards' and reducing the customer's electric bill.

	**NOTE:** Many common types of 'smart meters' do not deduct exported power from the recorded total. If you have a smart meter, be sure to contact your utility for a bi-directional smart meter or dual-meter installation, to ensure credit for excess energy production.

High Winds

In high winds the turbine will continue to operate, but the controller will limit the power output and speed. It is normal for the turbine to briefly exceed the rated power during high or gusty winds. In winds exceeding 30 m/s (66 mph), the turbine will curtail its speed and output power to prevent damage. If the wind turbine controller shuts down the turbine for self-protection, it will enter "high wind" mode. High wind shutdown will last for at least 10 minutes and will be longer if the wind continues at an extreme speed. When the wind returns to more moderate speed, the turbine will resume normal operation.

3.4 Power Outages

In the event of a power outage, the inverter is required to shut off to prevent a hazard to utility repair personnel. The turbine will enter the 'disabled' state until power is restored. ***Ask your dealer about battery-backed system options that will allow your turbine system to operate and provide power to your home during power outages.***

3.5 Manually disabling the turbine

The turbine may be temporarily disabled from the inverter. The turbine should be disabled for raising and lowering, and owners may also choose to disable it in extreme weather (such as an approaching hurricane or tornado).

To disable the turbine:

- From the front panel display of the inverter, scroll horizontally to the turbine page.
- Press the center button to show the menu
- Select 'Disable' from the menu options and press the center button
- Press the center button once more to confirm
- The wind turbine page on the inverter front panel display will report 'disabled'.

To re-enable:

- From the front panel display of the inverter, scroll horizontally to the turbine page.
- Press the center button to show the menu
- Select 'Enable' from the menu options and press the center button
- Press the center button once more to confirm
- The wind turbine page on the inverter front panel will report the turbine's current state

4 States, Faults and Errors

4.1 States

State Name	Description	Comment
Offline	The turbine is not able to communicate with the inverter; this state is reported when REbus is not powered up	Sometimes caused by a bad earth connection between turbine and inverter
Powering Up	The turbine's internal systems are settling	Prolonged time in the Powering Up state can be the result of an unstable bus voltage
Low Bus Voltage	REbus voltage is too low to operate	
Disabled	Turbine is manually disabled	Turbine will not start up without user input
Low Wind	Not enough wind to operate	
Making Power	Normal operation mode	
Waiting	Temporary timeout as result of startup sequence or a fault	Turbine will automatically restart after timeout period has elapsed; see Faults section below.
High Wind	High wind shutdown mode	Turbine will restart 10 minutes after extreme wind event passes
Error	Error mode	Turbine will not automatically restart; see Errors section below.

4.2 Faults

The T701 turbine features sophisticated microprocessor control, and is capable of sensing and responding to events including high winds, extreme temperature variations, and vibration due to imbalance (e.g. caused by ice). If the turbine seems to behave in an unusual way, check the inverter front panel display for status messages. A turbine that is frequently in the Waiting state might be experiencing multiple faults. Contact Pika Energy to investigate what can be done to improve your system's performance.

4.3 Errors

An Error state results from a serious condition detected by the wind turbine that has caused it to shutdown permanently. It will not restart automatically. Contact Pika Energy to understand the nature of the error and how to rectify it.

4.4 Backup Safety Brake

The T701 turbine is equipped with a centrifugally operated cam brake that engages in the unlikely event that the primary control fails, to prevent extremely high speed operation and the risk of damage to the turbine and surrounding property. If the safety brake engages, the turbine will not spin until the turbine can be serviced.

	**WARNING :** Engagement of the safety brake indicates a serious problem with the control circuit or alternator. Do not attempt to reset the brake to put the turbine back into service without first correcting the underlying issue.
	**WARNING:** The safety brake cam is a single-use part, and must be replaced by the factory or a qualified field service technician before the turbine is allowed to run again. Do not attempt to reset the brake.

5 Inspection and Maintenance

The T701 turbine has been designed to give years of trouble-free service. Pika Energy recommends the following inspection and maintenance schedule:

5.1 After first month of operation:

Perform the annual inspection described below.

5.2 Monthly:

Check that turbine operation appears normal.

5.3 Annually:

Inspect the turbine carefully from the ground while it is operating in moderate winds. Put your ear against the tower and listen for any unusual clicks, rattles, scrapes, thumps, or grinding noises. It is normal to hear a low hum that changes pitch with the speed of the rotor.

Check condition of tower, including turnbuckles, turnbuckle safety cables, anchor rods, tower base bolts, and tension of guy wires, with reference to tower manufacturer's instructions With turbine disabled, tighten or adjust as necessary.

5.4 Every 10 years of operation (5 years in high wind site):

A qualified installer should lower the tower and carefully inspect the turbine, paying special attention to the blades, hub, shaft, bearings, and shrouds. The backup safety brake cartridge should be inspected to ensure free movement of the brake mechanism and correct release torque.

Pending real-world lifetime data from the field, Pika Energy provisionally recommends replacing the mainshaft/bearing assembly, bladeset, and blade attachment fasteners every 10 years. Contact Pika Energy tech support for updated recommendations.

While the tower is lowered, the installer should carefully check the tower for chafing, wear, or loose fasteners, and tighten or replace parts as appropriate.

5.5 End-of-life:

Pending real-world lifetime data from the field, Pika Energy provisionally recommends a factory re-build of your T701 turbine after 30 years in the field (20 years in high wind sites).

Major components of the T701 turbine including blades, hub, and nacelle castings are recyclable. Pika Energy strongly recommends recycling your turbine when its useful life is over.

6 Troubleshooting

Use the table below to help diagnose issues with theT701 turbine.

Symptom	Possible cause	What to do about it
Turbine spins very slowly in wind that would normally cause operation	turbine disabled	Check status of turbine at inverter front panel display. Enable turbine.
	REbus shorted	Check REbus voltage at inverter front panel display. If the inverter is not able to enable and bring up the bus voltage, it may be the result of a bus short. Disconnect all sources of power and troubleshoot REbus wiring.
	Fault in alternator or control circuit	Check turbine status at inverter front panel display. Contact your installer or Pika Energy for more information.
	REbus microgrid not active	Check REbus status at inverter front panel display; enable the inverter and check REbus voltage.
	turbine disconnected from REbus	Check turbine status at inverter front panel display. "Offline" indicates turbine is not communicating with inverter. Make sure DC disconnects are closed. Check wiring for open circuits.
Turbine does not spin at all in moderate to high winds	Safety brake engaged due to control circuit failure	Call your installer
	Failure of alternator or bearings	Call your installer
Turbine vibrates, or makes grinding or chunking noise	buildup of ice on blades or hub	No cause for concern. Turbine will sense vibration and limit speed. Wait for ice to melt.
	Failure of alternator or bearings	Disable turbine immediately at inverter front panel display; call your installer
Blades whistle or howl in moderate to high wind	Damage to blade from flying debris	Disable turbine immediately at inverter front panel display; call your installer
Turbine does not orient to wind	Seized yaw bearings	Disable turbine immediately at inverter front panel display; call your installer

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